Journal of the Indian Fisheries Association
31, 2004, 155-165

10

TECHNO-ECONOMIC ANALYSIS OF PRODUCTION AND MARKETING OF MARINE BY-PRODUCTS IN INDIA

R. Sathiadhas and N. Aswathy

Central Marine Fisheries Research Institute, Cochin - 682018.

ABSTRACT

Marine by-products coming under the ancillary products group found many applications in pharmaceutical and industrial sectors. Although many of these products are fetching very high price at the export market, adequate statistics regarding their current production, marketing and utilisation is lacking. The present analysis deals with the production potential, level of exploitation, uses, export growth rate and potential for the future of some of these marine by-products. The analysis revealed that an estimated quantity of 205 tonnes of shells, 10 tonnes of gastropod operculum, 4,932 tonnes of shark liver oil and 4,384 tonnes of shark cartilage could be produced annually in India with the current landings. The production potential of chitin is estimated as 3,560 tonnes from shrimp shell wastes and 1,354 tonnes from crab shell wastes. The high unit value of different products clearly indicates the scope for their development by evolving appropriate utilisation and marketing strategies.

Keywords: by-products, production potential, marketing, growth rate

INTRODUCTION

The export of ancillary marine products constituted 0.65 percent in terms of quantity and 0.33 percent in terms of value of the total marine exports during the year 2000 (MPEDA, 2000). Ancillary marine products include products of marine origin used directly other than the routine consumption purpose and by-products. A byproduct by definition is a product produced accidentally during the production of a main product or product produced in addition to the main product. There are a vast variety of products such as chitin and chitosan produced from shrimp and crab shell wastes, shark products like liver oil, skin leather, cartilage and teeth, cuttle fish products of bone and ink having very high export demand. There are a number of applications including pharmaceutical and industrial uses were identified for these products. Although many of these products are fetching very high price at the export market, adequate statistics regarding their current production, marketing and utilisation is lacking. The present analysis deals with the production potential, level of exploitation, uses, export growth rate and potential for the future of some of these marine byproducts.

MATERIAL AND METHODS

Both primary and secondary data have been collected and utilised for the study. Secondary data on quantity and value of different marine products exported were obtained from various issues of "Statistics of marine products exports" published by Marine Products Export Development Authority (MPEDA) and landings data were collected from Annual Reports of Central Marine Fisheries Research Institute. The primary data regarding processing and marketing of marine by-products were collected through a questionnaire from selected exporting firms in Aroor and Neendakara region of Kerala and processing units in Tuticorin region of Tamilnadu.

Conventional averages and percentage analysis were done for working out the average quantum of landings, production potential and contribution of by-products in the total marine exports. Compound annual growth rate equation of the form given below was used for determining the export growth trend of all marine products and selected non-edible products during the period from 1991-2000:

$Y=ab^t$

The major marine by-products covered under the present analysis are given below.

i) Chitin and chitosan produced from shrimp and crab shell wastes ii) Fish maws and isinglass iii) Fish meal produced from trash fish iv) Shark products like, liver oil, skin, cartilage, teeth v) Sea shells and vi) Cuttlefish bone and ink.

RESULTS AND DISCUSSION

i) Chitin and its derivatives

Chitin is a major constituent of the exoskeletal material of crustaceans, cuttlefish and squid. Chitin is a product obtained after the de-proteinisation and demineralisation process of shrimp and crab shell wastes. About 40-55% in the case of shrimps and over 70% in the case of crabs are discarded as waste during processing. The processing waste of these species contains approximately 10-55% of chitin on dry weight basis, depending on the processing method. Japan and U.S.A. are the leading producers of chitin followed by India, Italy and Poland. The different uses of chitin are poultry growth promoter, preparation of natural cosmetic soap, preparation of slimmer capsules, in paper industry, in textile industry for giving fineness to fibre, for removing poison from aquaculture plants, preparation of hair dyes and for making surgical sutures.

A study conducted in Neendakara and Aroor regions of Kerala to know the extent of utilization of shrimp and crab shell wastes for chitin and chitoson production revealed that there are about 350 peeling sheds of shrimps in Aroor region of Alappuzha District, each generating shrimp shell wastes ranging from 500 to 2500 kg per day. (Table 1) These peeling sheds together produce on an average 300 tonnes of shrimp sheel waste per day. The waste is usually discarded to be used for making poultry feed, fishmeal and tooth powder. Only a very few firms produce chitin and chitosan from the shell wastes. These units are collecting shell wastes at

Table 1 : Utilisation pattern of shell waste for chitin and chitosan in the study regions

Name of the locality	No. of peeling sheds	Average shell waste Production (kg/day/unit)	Shell waste production (tonnes)	Uses of shell waste	No. of units producing chitin	Chitin production (tonnes)
Aroor	350	900	300	Chitin Production, fishmeal, poultry feed, tooth powder	3	15
Neendakara	20	1000	20	Discarded	1	3

price ranging from Rs.5-10/box of 40 kg. The chitin recovery is 3% from shrimp shell wastes and 5-6 percent from crab shell wastes. The cost of production of chitin is Rs.100 per kg including labour and raw material. The total production of chitin by these units is 15 tonnes per month, which require only 500 tonnes of waste per month. The private commercial firms mainly export the chitin and chitosan produced and the domestic consumption of the same is very less. Nearly 97 percent of the shell waste used for chitin production goes as effluent and the cost of effluent treatment become a major problem in chitin production.

In Neendakara region, in addition to the large shrimp exporting firms, nearly 20 peeling sheds are generating shrimp shell waste. It is either discarded or used as manure. The chitin production unit of Matsyafed located at Neendakara obtains shell waste from peeling sheds in Alappuzha District. At present they are not able to utilise the full capacity because of the non-availability of shell wastes.

It is estimated that about 30,000 tonnes of shrimp & crab shell wastes are available in Kerala out of the total landings of 56,462 tonnes of penaeid prawns and 5,894 tonnes of crabs. Currently only about 150 tonnes of chitin is produced annually by different units in Kerala. By proper utilisation of the available shell wastes, 1,200 tonnes of chitin can be produced annually and the environmental problems associated with shell waste disposal can also be minimised.

The average production of penaeid and non-penaeid prawns in India during the last five years is 3,29,589 tonnes (Table 2). The main source of shell wastes for commercial chitin production is from the exporting firms of frozen shrimp and shrimp products. Assuming 90 percent of the shrimps and crabs are exported, the shrimp shell wastes available annually for chitin production is 1,18,652 tonnes and

Table 2 : Annual landings of different categories of marine fishes in India

Years	Shrimps		Crabs	Eel	Catfishes	Sharks	Bivalves	Gastropods
	Penaeid	Non penaeid						
1995	1,79,143	73,999	30,610	5,904	38,493	45,953	28	1,143
1996	1,88,060	1,04,462	29,049	7,030	36,090	34,717	0	3,215
1997	2,08,801	1,53,642	44,965	7,792	44,684	44,897	905	890
1998	2,14,948	1,73,950	34,293	9,594	52,710	47,430	501	1,182
1999	1,74,340	1,47,908	27,689	11,381	47,131	41,512	109	901
2000	2,06,998	1,51,283	48,268	9,187	58,332	48,525	219	503
Average	**1,95,382**	**1,34,207**	**35,812**	**8,481**	**46,240**	**43,839**	**293**	**1,305**

Source : Annual Reports, CMFRI, 1995-2000

crab shell wastes, 22,561 tonnes (Table 3). Thus the annual chitin production potential is 3,560 tonnes from shrimp shell wastes and 1,354 tonnes from crab shell wastes.

ii) Dried fish maws and Isinglass

Fish maws are the washed and dried air bladder of fish. The following species of fishes namely, eel, jewfish, thread fin breams, giant croaker, catfish, sea perches and lizardfishes are used for making fish maws. It has got very good demand in several foreign markets.

Isinglass is the product obtained by drying the air bladders of fishes like eel and catfish. It is semi solid gel obtained by drying of the air bladders in sun for 48 hours and then soaking in 2% acetic acid with a p^H of about 2.5 for four hours (Badonia & Qureshi, 2000). The market price of powdered isinglass at present is Rs.600/Kg. It is mainly used for the clarification of beverages.

The average landing of eel during the last five years is 8,481 tonnes and of catfishes is 46,240 tonnes. Assuming the fish maws recovery of 1-3% from fresh fish, the annual production potential is 254 tonnes from eels and 1,387 tonnes from catfish (Table 6). The main sources of air bladder for the commercial production of fish maws and isinglass is the firms exporting frozen and canned fish.

Table 3 : Annual production potential of Chitin in India

Sl.No.	Source	Average Landing (1995-2000) tonnes	% of Shell Waste	Estimated quantity of shell waste (tonnes)	% recovery of chitin	Production potential of chitin (tonnes)
1.	Shrimps	3,29,589	40	1,18,652	3	3,560
2.	Crabs	35,812	70	22,561	5-6	1,354

Source : Annual Reports of CMFRI 1995-2000

iii) Fish meal

Fish meal is a highly concentrated nutritious feed supplement produced by cooking, pressing, drying and grinding of the skeletal remains along with the adhering proteinaceous tissues of fish from filleting or canning operations of by processing trash fish obtained as bycatch along with other high valued species (Pike, 1999). Fishmeal and fish oil are produced mainly from species of fish which are either not suitable for direct human consumption or for which there is a limited demand. Trimmings from fish processed for human consumption are also used, though these would account for less than 10 percent of fishmeal and fish oil production. The species of fish, which are mainly used for fishmeal and oil are anchovy, sardines, horsemackerel etc. Currently the fish bycatch is estimated to be 30 million tonnes and this is currently almost equivalent to the fish raw material used in fishmeal and fish oil production. Highest user of fishmeal is poultry, that is in broiler and breeder diets. Pigs are the next followed by aquaculture.

iv) Shark products

a. Liver oil

The liver of shark contains 60 to 75 percent oil. Squalene obtained from shark liver is used for the prevention and treatment of cancer, heart attacks, and hepatitis, Hydrogenated squalene (Squalane) is used in the preparation of cosmetics, perfumes, aromatics and as anti-aging agent and lubricant in finishing silk and wool. (Larsen, 2001). The liver after pressing for obtaining oil contains protenaceous tissues along with high content of vitamin A and B. It is used for the preparation of fishmeal. The average annual landings of sharks in India during 1995-2000 is 43,839 tonnes (Table 2). The shark liver constitutes 15% of the body weight of sharks and the recovery of oil from the liver is 75%. Thus there is an annual production capacity of 4,932 tonnes of shark liver oil with the current landings.

b. Shark cartilage

Shark cartilage is a rich source of Calcium. Until recently only very small quantity of this was used for making ornaments. Now shark cartilage powder is identified as a health food, anti cancer and anti viral agent. It is also used in cosmetics (Subasinghe, 1999). The major producing and consuming countries are USA, Japan, Australia and India. The production and trade of shark cartilage is not documented at present. The markets for this has substantially increased in the last few years and the prices are very high. It has got a well-developed market worth one billion dollars a year in U.S.A. Shark cartilage constitutes 10 percent of the body weight of sharks and the annual production capacity of shark cartilage with the present shark landings is about 4,384 tonnes.

c) Shark skin & teeth

Shark skin leather is a byproduct from shark fishery. The skin is used for the preparation of novelties. Shark skin is mainly used for the niche leather markets in France, Spain, Japan and USA. Shark teeth and bones are used for making fancy ornaments (Vannuccini, 2000). This has

got very good demand for export to countries like U.S.A., U.K., Canada, Australia etc. The price varies depending on the size and shape of teeth and teeth of atleast 20mm length are highly preferred. Among the various species, tiger shark teeth are in great demand due to its attractive shape and size. The techno-economic analysis of processing of different shark products in Tuticorin region showed that on an average the processing unit receives a profit of Rs.53,000 per month. (Table 4).

v) Sea shells

The seashells constitute the external cover of bivalves and gastropods and the internal bone of cuttle fish. These shells have both ornamental and medicinal value. In addition to this, these are also used as rich sources of calcium.

The oyster shells contain 52-55% calcium oxide and are used in the manufacture of calcium carbide, lime and cement. The shells crushed to suitable size

Table 4 : Techno Economics of processing and trading of shark by-products in tuticorin

Item	Place of procurement of raw Material	Average quantity processed/ traded per month	Processing cost		Transport cost (Rs./ month)	Selling price	Use
			Labour Charges/ month	Boiling/ drying costs/ month			
Shark teeth	Kanyakumari, Mandapam, Rameswaram	50-100 nos(6-12kg)	9000	1500	Rs.4000	Rs.12600 (@Rs.1400/kg)	Fancy ornaments (export market)
Shark skin	—"—	100-200kg	9000	Nil		Rs.48000 (@Rs.320 /kg)	Leather bags, sandals (export market)
Shark liver oil	—"—	6-20 barrels (600-2000	13500	3000		Rs.32500 (@Rs.25 /kg)	For coating boats, ships and as fuel for trucks (domestic market)
Total			31,500	4,500	4,000	93,100	

Total cost = Rs.40,000/-
Total returns = Rs.93,100/-
Profit/month = 53,100/-

are used as poultry grit. Dried oyster shell powder is exported mainly to countries like Baharain islands, Kuwait and UAE. In 2000, 1,378 tonnes of oyster shell worth Rs.40 lakh was exported to these countries alone.

Kerala leads in clam production with 73 percent of the total clam landings. Shell is used in the manufacture of cement, calcium carbide, sand-lime bricks and lime. The shell lime is used for manuring coffee plantations, as a mortar in building constructions, in the treatment of effluents, as a pesticide for mixing with copper sulphate and in glass, rayon, polyfibre, paper and sugar industries. The average production of bivalves during the period from 1995 to 2000 is 293 tonnes. An estimated quantity of 205 tonnes of shells could be produced annually with this production. (Table 6).

The gastropods constitute 5-7 percent of the bycatch of shrimp trawlers (Appukkuttan, 1994). The shells and operculum of gastropods, mainly *Xancus pyrum* and *Babylonia* sp. fetch very high price both in the domestic and export markets. Sacred chank is prevalent in Kerala, Tamilnadu and Gujarat coasts. The sacred chank has a regular market in West Bengal for the shell bangle industry. In addition, it is used for blowing as trumpet in religious ceremonies. The horny operculum of the shell is of great demand for preparation of incense sticks. The shells are used for ornamental purpose.

Table 5 : Annual Operating costs and returns of a cuttle bone processing unit in tuticorin

Items of cost	Costs (Tonnes/)
Fixed cost	
Establishment cost of hot air driers	Rs.35,000
Establishment cost of grinders	Rs.12000
Annualized fixed cost (Depreciation + interest on fixed investment	7520
Operational costs	
Quantity of cuttle bones and wastes processed/year	50 tonnes
Purchase price of bones and wastes	Rs.0.25/kg
Cost of transporting raw material	Rs.5,000
Labour charges (3 labourers @ Rs. 90/labourer/day)	Rs.81,000
Processing cost (hot air drying and grinding)	Rs.3000
Cost of transporting final product to exporting firm in Chennai	Rs.7000
Total Cost	**1,03520**
Returns (@ Rs.30/kg)	1,50,000
Profit	Rs.46,480

Table 6 : Estimated production potential of different marine by-products

Sl. No.	Item	Source	Average Landing (1995-2000) tonnes	% recovery	Production potential (tonnes)
1.	Shark cartilage	Shark	43,839	10%	4384
2.	Shark liver oil	Shark	43,839	11.25%	4932
3.	Fishmaws & isinglass	Eel & Catfishes	54721	1-3%	1641
4.	Gastropod operculum	Gastropods	1305	1%	10
5.	Sea shells	Bivalves	1598	80%	1278

The operculum is collected from the gastropods after boiling it and then drying the cleaned material. It is marketed under the trade name fish nails. It fetches a price of Rs. 500 per kg. In South India, it is collected from different landing centres by the agencies located in Tuticorin region and then transported to Calcutta, where further processing is done. This is mainly used in perfumery industry.

The average gastropod landings during the period 1995-2000 is 1,305 tonnes and annual production of gastropod shells is estimated as 1,044 tonnes (Table 6). The operculum constitutes 1% of the shell weight and the operculum production potential of India is estimated as 10 tonnes.

vi) Cuttle fish bone & ink

The bones of cuttle fish have many pharmaceutical and industrial uses. Cuttle fish bones are rich in calcium and trace minerals. It is used locally for cleaning mirror. Dried powdered cuttle bone is used as feed for reptiles and birds. It is used in medicines to relieve earache. Cuttle bone in powder form is used as external application to prevent skin diseases. It is also used in the manufacture of perfumes and talcum powder. In Aroor, cuttle bones were collected by the traders at a cost of Rs. 10 per box weighing 40 kg from the firms exporting cuttlefish. It is then transported to Tamilnadu region where it used in the manufacture of perfumes and talcum powder. In Tuticorin region of Tamilnadu cuttle bones along with waste materials from the cuttle fish exporting firms were collected, cooked in hot ai driers sun dried and ground in to a powde form which is exported for use as poultr feed. The techno economics of cuttlebon processing for poultry feed showed tha the firm earns an annual profit Rs.46,000 by processing 50 tonnes of bon and wastes (Table 5). Cleaned dried cutt bones of different sizes are also export for different purposes. Usually bones havi above 6" size are preferred for export. It mainly exported to UK and Japan.

Cuttle fish ink was used in the pa as a tint for artist's paints and also writing ink. Some of the cuttlefi exporting firms in Aroor and Neendak region were collecting the ink sac and i exported after tying the ink sac. Sinc

is a laborious process its export is very limited nowadays. It is also used in the preparation of homeopathic medicines.

Marketing

At present there is no organized system of marketing for many of these products. Hence the exact status on domestic consumption and prices of these products are not available. Many of these products are fetching very high price at the export market. The unit value realization of different marine by-products obtained from the export statistics is given in Table 7. Among the different marine by-products, dried isinglass fetches a price of Rs. 600/kg. dried chitin Rs.252/kg and dried chitosan Rs.455.82/kg. The high unit value of different products clearly indicates the scope for their development by evolving appropriate utilisation and marketing strategies.

The export of all ancillary marine products together showed a compound growth rate of 18.53% in terms of volume and value during the period 1991-2000 (Table 8). The total marine product exports also showed the same growth rate during this period. Chitin grew by 40.8% in terms of quantity and 53.08% in terms of value. In terms of value, seashells showed the highest growth rate of 91.53% whereas fish maws showed a growth rate of only 19.46%. Even though the export of byproducts constitute less than one percent of the total marine products exports, their future potential is immense considering the high export price of many of these products. Also since many of these products are waste materials from marine catch, this will further facilitate in generating additional revenue and help in reducing the environmental problems associated with waste disposal.

Table 7 : Unit value realisation of major ancillary marine products from India (Export market, 2000-01)

Sl. No.	Product	Export		Unit value (Rs./kg)
		Quantity (tonnes)	Value (in Rs.lakhs)	
1.	Dried chitin	17.50	44.16	252.36
2.	Dried chitosan	4.06	18.51	455.82
3.	Dried fish maws	521.89	1580.76	302.89
4.	Dried isinglass	56.19	29.01	516.4
5.	Dried fish meal	40.00	7.87	19.67
6.	Dried cuttle fish bones	1.94	8.03	40.29
7.	Dried oyster shell powder	1378.14	40.35	2.93
8.	Dried fish nails	.71	2.48	347.72
9.	Shark bones	52.97	48.86	92.24
10.	Crab shells	38.54	44.09	114.40
11.	Sea shells	417.91	106.92	25.59
	TOTAL	**2529.85**	**1931.04**	**Average unit value = 180.85**

Source : Statistics of marine products exports, MPEDA, 2001

Table 8 : Export growth rate of selected ancillary marine products during 1991-2000

Sl.No.	Product	Compound growth rate		
		Quantity	Value	Price
1	Chitin	40.8*	53.08*	8.68*
2	Sea shells	38.3	91.53	15.77*
3	Fish Maws	20.9*	19.46*	-1.27
4	All ancillary products	18.53*	18.53*	0.14
5	All marine products	10.48*	18.53*	7.66*

* Significant at 5% level

Conclusion & Policy Implications

The results of the study revealed that an estimated quantity of 205 tonnes of shells, 10 tonnes of gastropod operculum 4,932 tonnes of shark liver oil and 4,384 tonnes of shark cartilage could be produced annually with the current fish landings. A survey on the extent of shell waste utilisation for chitin production in Kerala showed that about 30,000 tonnes of shell wastes is available in Kerala alone and by proper utilisation of the same, 1,200 tonnes of chitin can be produced annually. In India the annual chitin production potential is estimated as 3,560 tonnes from shrimp shell wastes and 1,354 tonnes from crab shell wastes. The high unit value of different products clearly indicated the scope for their development by evolving appropriate utilisation and marketing strategies. The export trend analysis for the period from 1991 to 2000 showed that the overall growth rate of ancillary marine products is on par with the exports of total marine products.

Many of the marine by-products find application in industrial and pharmaceutical sectors, the end products of which are very costly and out of reach of the domestic consumers. Hence elaborate and continuous research to identify the chemical composition and presence of bioactive compounds in these products is needed, which should be accompanied by domestic production, cataloging and patenting of the products. The potential available in this sector should be exploited for generation of alternate employment opportunities and income for coastal women folk.

As no statistical information is available at present regarding the domestic and export trade of many of these products, research studies regarding the quantification of domestic and export trade volumes and identification of trade channels should be given top priority. Considering the diminishing catch and over exploitation in the marine fisheries sector, the marine byproducts offer

promising scope for ensuring alternate employment opportunities and income for the coastal fisherfolk. Hence a comprehensive policy on production, marketing conservation and utilisation of all ancillary marine products is essential to optimise employment and earnings of fisheries.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. Mohan Joseph Modayil, Director, CMFRI for the facilities provided. Thanks are also due to Ms. Sheela Immanuel, Ms. K. P. Salini and Mr. Jijo Joseph of SEETT Division and Mr. Habeeb Mohammed, TRC of CMFRI, Tuticorin for their help in the collection of data and preparation of this paper.

REFERENCES

Appukkuttan, K.K. and Babu Philip, M., 1994. Gastropods- An emerging resource in the by-catch of shrimp trawlers at Sakthikulangara-Neendakara area. *Seafood Exp.,* **XXV (21):** 5-17.

Badonia, R. and Qureshi, T.A., 2000. Isinglass from fresh water fish maws. *INFOFISH Internal.,* **5:** 55.

Larsen. Hans R., 2001. Fish oils: The essential nutrients. *MPEDA Newslet.* **VI(2):** 8-11.

Marine Products Export Development Agency 2000. *Statistics of marine product exports.* 80 pp.

Pike. Ian H., 1999. Future supplies of fishmeal and fish oil: Quality requirements for aquaculture. *Fish World.* **7(7&8):** 8-14.

Vannuccini, Stefania, 2000. Markets for shark products. *Fish World.* **3:** 26-33.

Subasinghe, S., 1999. Chitin from shellfish waste-health benefits over shadowing industrial uses. *Fish World* **3:** 58-64.